Nelson Tasman Site Classification Study

Defining the dynamic site characteristics of the Nelson-Tasman region subsoil materials

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Nelson-Tasman Geology

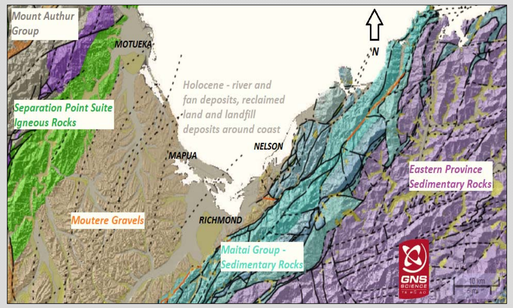

Figure 1: Geology of the Nelson-Tasman Region, GNS Nelson Urban Area Geological Map, 1:25000 New Zealand Geological Survey (2014)

The Nelson-Tasman region is a rugged mountainous area formed of very hard rocks, some of which are among the oldest in New Zealand (GNS, 2016). The area comprises recently deglaciated Tasman Mountains in the west and the lower Richmond Ranges and other ranges in the east separated by the low-lying Moutere Depression.

The Moutere Depression is a 30 km-wide system of valleys between the Tasman Mountains and the ranges of the east Nelson. The depression was formed in the Pliocene-Pleistocene during uplift of the Tasman Mountains and east Nelson ranges. The Moutere Depression is fault-bounded to the east by the northeast-trending Waimea-Flaxmore Fault.

The Moutere Depression is an area of geological research interest and there are a number of existing interpreted seismic surveys intersecting this feature (Figure 2). From this existing information magnetic and gravity anomalies within the basin have been identified, as well as indications of a number of significant faults. It is likely that this geomorphologic structure will also have future studies carried out to better understand its existence and the information it holds about the possible seismic threat to the Nelson-Tasman region.

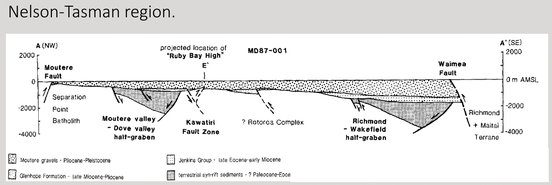

Figure 2: Cross section through the Moutere Depression showing the interpreted seismic survey information through MD87-001, Lihou (2010)

The Nelson-Tasman region is bounded by a number of faults (Figure 3) and has been impacted by a number of large magnitude events in previous years. Deep soil and gravels deposits are present in this area which may lead to significant amplification of seismic ground shaking and possibly 'basin effects'.

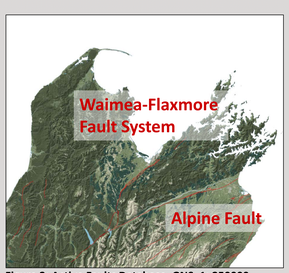

Figure 3: Active Faults Database, GNS, 1: 250000

Project Objectives

The project objective is to determine and map dynamic site characteristics across the Nelson-Tasman region and therefore assess the potential seismic site response including soft-soil amplification effects.

A combination of geotechnical and geophysical methods are to be used in a region-wide study of the developed urban areas of Nelson-Tasman. Collection and reference to existing sub-surface information will be utilised to identify geological trends across the region that can then be used to better define and interpret the collected geophysical testing information.

To achieve this, the following goals were set:

1. Collect existing geotechnical subsurface information from around the region, understand the geological and geomorphological features of the area.
2. Estimate the site period over a grid of sites across Nelson-Tasman focus using horizontal-to-vertical spectral ratio (HVSR).
3. Undertake Multi-Channel Analysis of Surface Waves (MASW) testing to define the shear wave velocity profile for selected sites across the region.

Existing Regional Sub-Surface Information

Collecting existing sub-surface information was the first step of this project. Factual geotechnical data is useful for identifying regional geological trends, identifying areas of interest for further testing and constraining data collected from geophysical testing.

Existing sub-surface geological information has been collated and plotted spatially as shown in Figure 4. Over 500 records were gathered from Nelson City Council and Tasman District Council records, local consultants and contractors from around the region. Factual borehole logs and Cone Penetration Test (CPT) logs extending to depths of 5m or more were included in the database and referenced by a unique number. It was anticipated that this factual information would be included in the New Zealand Geotechnical Database, so the relevant identification details were also captured to minimise the additional effort then needed to upload this data to the New Zealand national database.

For each factual log, the following information was itemised in the database for reference and ease of filtering the data: Site investigation location co-ordinates, total depth of borehole/CPT factual information, groundwater table if observed, drilling contractor, consulting company, client, date drilled, RL elevation of the site and the depths to rock or basement gravels where relevant.

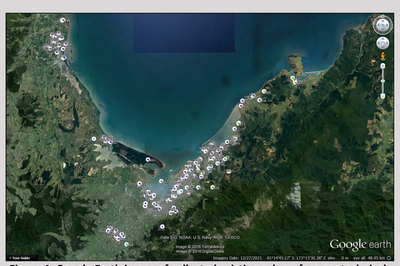

Figure 4: Google Earth image of collected existing sub-surface geotechnical information (total of 500 records)

Geophysical Testing

Geophysical testing techniques will be employed for this study to estimate dynamic characteristics at a number of sites around the Nelson-Tasman region. Using factual logs from the collated sub-surface information database, or by carrying out additional geotechnical investigations, the geophysical data will be verified and constrained.

Figure 5: Site photo of geophysical testing set-up linear array of geophones.

Surface Wave Testing

Rayleigh and Love waves are surface waves, generated when seismic body waves interact with the earths surface. This project proposed to utilise both active and passive surface wave testing acquisition methods to determine the dynamic characteristics of the underlying subsoil materials.

A linear array of geophones is to be utilised at each site with either an active source of seismic waves (sledgehammer or drop-weight) or passive source (ambient long period waves generated by a number of sources, both natural and man-made). Figure 5 is a photo of the experimental set up including the linear geophone array which will be used for the proposed surface wave testing.

Horizontal-to-Vertical Spectral Ratio

HVSR measurements provide an estimate of site period by taking a ratio of the horizontal and vertical spectral data collected by a 3D seismometer. It has been shown that this approach normalises source and path effects, providing information specific to the particular site that is being investigated.

Proposed Outcomes

This project aims to fill the current knowledge gap for the Nelson-Tasman region and provide engineers, local councils, asset owners and emergency planners with an initial assessment of the dynamic site characteristics.

The primary outputs from this project include a database of collected factual sub-surface information (existing and new information) and presentation of dynamic site parameters derived from geophysical testing.

Like similar studies around New Zealand, this information will also help with future ground motion modelling, both regionally and for nation–wide studies.

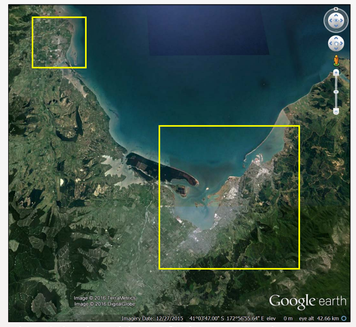

Figure 6: Google Earth image of Nelson-Tasman region showing extents of focus study area

Next Steps

Using broadband seismometers, the next step for this project is to carry out HVSR measurements around the urban Nelson-Tasman region. Where possible, Council owned-parks have been identified for testing purposes. Selected park and reserve areas provide a free-field space with simple access requirements. Figure 7 below shows the spread of possible HVSR locations (blue dots) we propose to gather data from and the potential Council owned sites with sufficient space for MASW testing (large red circles).

Using this information, analysis and mapping of the collected data will be used to identify geotechnical/geophysical trends and areas of interest. Based on this, locations will then be targeted for further testing including MASW and sub-surface geotechnical investigations.

Additional activities which are part of this project include engaging with the region's Civil Defence organisation, liaising and communicating with Nelson City Council and Tasman District Council, and working alongside local geology research projects to develop better understanding of the deeper regional geology.

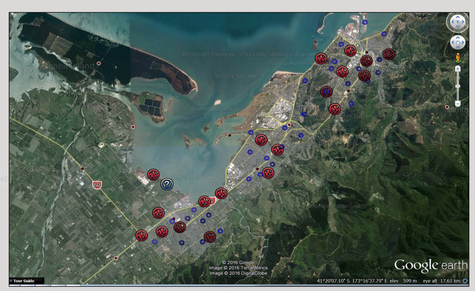

Figure 7: Google Earth image showing the locations of the proposed HVSR (blue dots) and MASW (large red circles)

References:

- GNS (2016) Geological Maps and Active Faults Database (1:250 000).
- Lihou (2010), Reinterpretation of seismic reflection data from Moutere Depression, Nelson region, South Island, New Zealand, New Zealand Journal of Geology and Geophysics, 35:4, 477 – 490.